A Real-Time Experiment Using PCTides 2.0

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Introduction: A real-time test of the Naval Research Laboratory's (NRL) globally relocatable tidal prediction system (PCTides 2.0) was performed during the naval exercise Autonomous Underwater Vehicle Fest 2005 (AUVFest 2005) that occurred June 6-16, 2005 in the Puget Sound, Washington, area. AUVFest 2005 was sponsored by the Office of Naval Research (ONR) and involved two weeks of intensive AUV experimentation and demonstration. PCTides 2.0[1] consists of a barotropic ocean model designed to forecast tidal currents and sea-level water elevations on or near continental shelves (Fig. 7). The system is set up to run on a PC or UNIX platform with a global database of bathymetry, boundary conditions, and tidal station data for assimilation purposes. During AUVFest 2005, PCTides 2.0 predicted water elevations and tidal currents using a series of grids with increasing resolution (Fig. 8). Tidal forecasts from the 1.5-km nest are presented here. The grids were run daily, producing a 5-day forecast of tidal height and currents with graphical results posted to the Naval Oceanographic Office (NAVOCEANO) website. During the exercise, the PCTides 2.0 tidal phase forecasts provided the optimum dive window for an AUV recovery exercise and a successful recovery of a bottom "crawler" stuck in the mud. Feedback from the divers was that the modeled tidal phase forecasts were "dead on."

Model Assessment: Two Acoustic Doppler Current Profilers (ADCPs) were deployed during AUVFest 2005 in the Hood Canal and Keyport areas. As of October 2005, the Keyport ADCP has not been recovered. Prior to AUVFest 2005, two ADCPs were deployed in the same area, and a preliminary study was performed using PCTides 2.0. These results showed good agreement and provided confidence in the system's forecasting ability for this region.

PCTides 2.0 forecasts of water-level elevations and tidal currents were compared to the ADCP at the Hood Canal location, demonstrating the ability of PCTides 2.0 to produce an accurate forecast. As the model resolution increased from 12 to 1.5 km, the predicted elevations improved. The root mean square error (rmse) decreased from 22 to 16 cm as the model resolution increased. The rmse for the phase for all grids was less than 25 min. As shown in Fig. 9(a), comparisons of the PCTides 2.0 water-level elevations forecasts were in excellent agreement to the observations.

The PCTides 2.0 depth-averaged current magnitudes agreed well with the Hood Canal observations. As the grid resolution increased to 1.5 km (Fig. 9(b)), the current magnitudes continued to improve, with rmse decreasing to 5 cm/s. The predicted tidal direction followed the same pattern as the tidal magnitudes. Both the 12- and 1.5-km grids had a mean error in current direction of 20 deg.
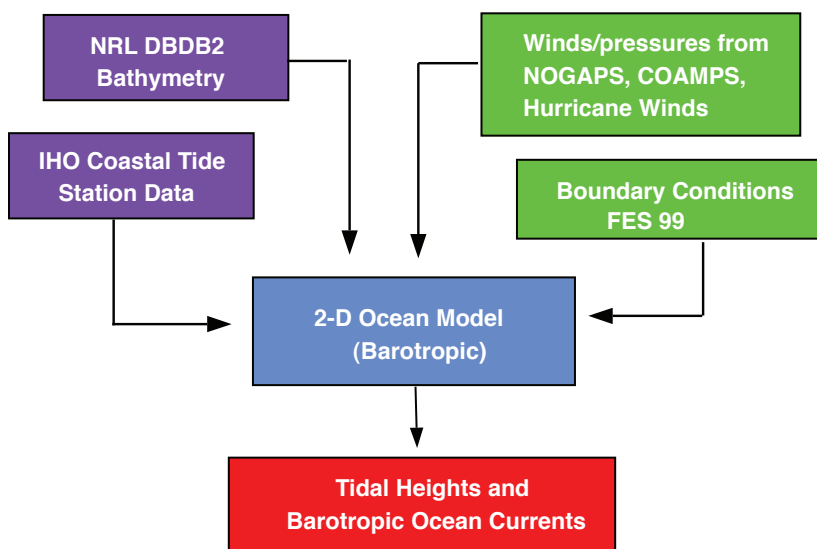
FIGURE 7
Components of the PCTides 2.0 system.
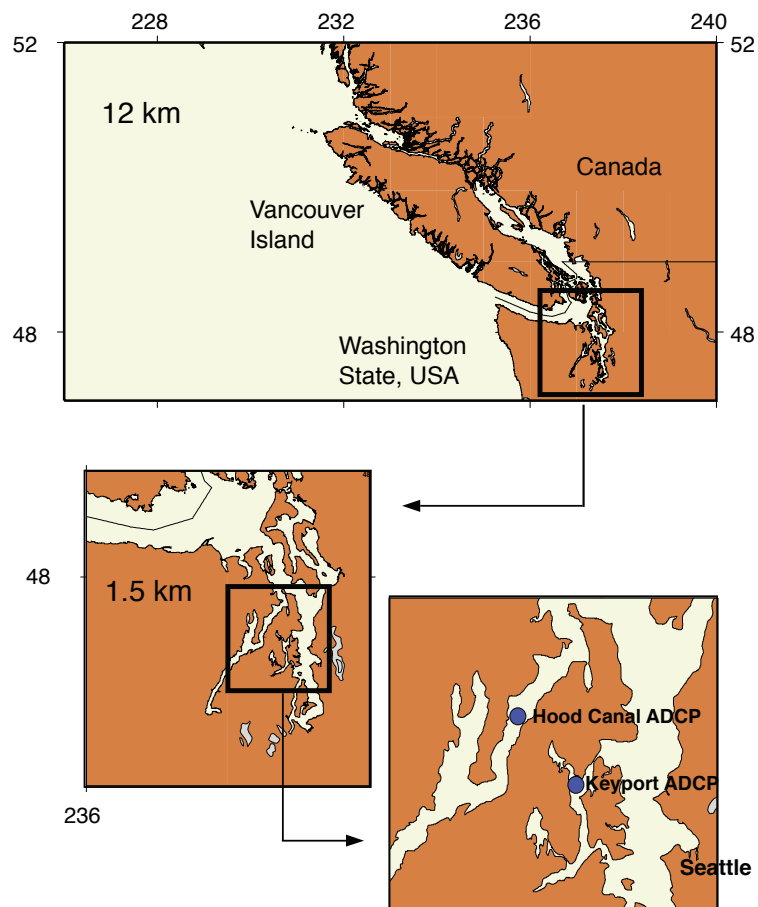
FIGURE 8
PCTides 2.0 grids (12 and 1.5 km) used in the AUVFest 2005. ADCP locations (circles) at Hood Canal and Keyport are shown in zoomed-in area.
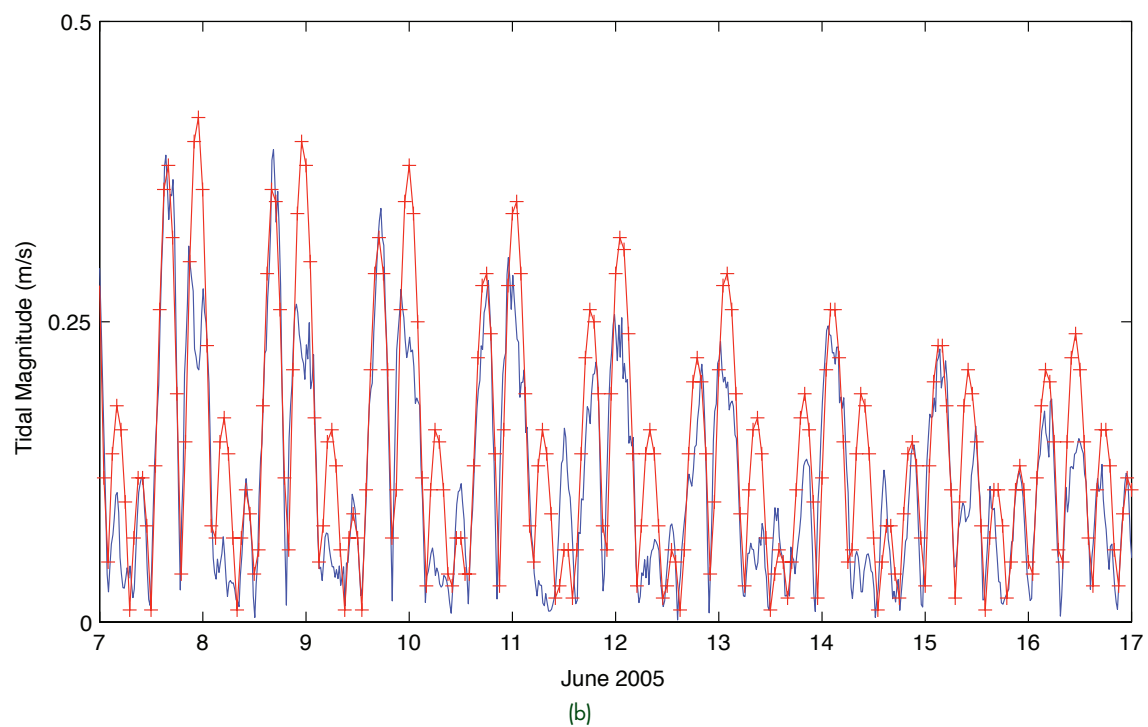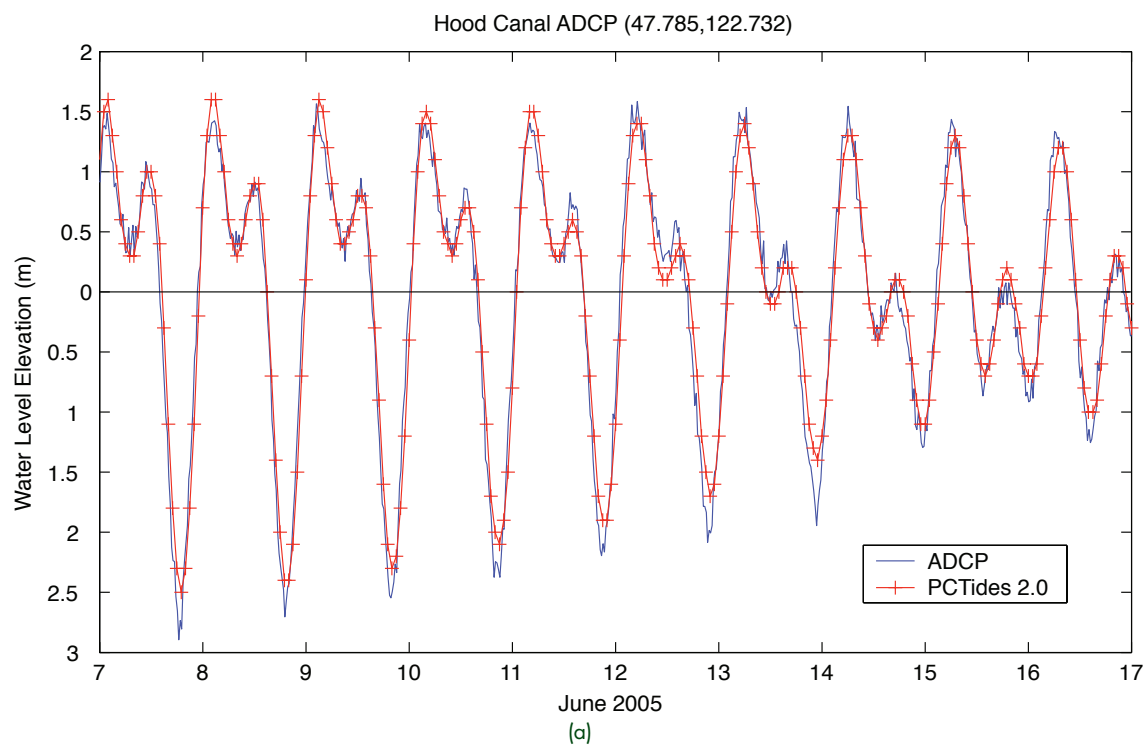
FIGURE 9
Hood Canal ADCP (blue) compared to PCTides 2.0 1.5 km forecasts for (a) water level elevation in meters and (b) tidal current magnitude in meters/seconds.

Summary: During the past five years, PCTides 2.0 has been rigorously tested in many areas and has produced realistic results within a short time frame (days). In the past two years, PCTides 2.0 has also been used to forecast tidal conditions due to storm surge. The model's forecasted storm surge have compared well against hurricane data from Isabel (2003) and Katrina (2005). In August 2005, PCTides 2.0 was accepted into the Oceanographic and Atmospheric Master Library (OAML) and can be distributed to all Department of Defense agencies. PCTides 2.0 currently has two patent applications pending. Overall, the PCTides 2.0 system has been shown to produce accurate and timely predictions of tidal conditions with favorable feedback from the Navy users.

Reference
[1] R.H. Preller, P.G. Posey, and G.M Dawson, "Hurricane Isabel: A Numerical Model Study of Storm Surge Along the East Coast of the United States," 85th American Meteorological Society Annual Meeting, San Diego, CA. P2.9 (2005).   ★